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Compliance Through Pollution Prevention: Strategy and Implementation at Edwards AFB

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1.0 INTRODUCTION

Edwards Air Force Base (AFB), located in the Mojave desert of southern California approximately 100 miles northeast of Los Angeles, is required to comply with the requirements of the California Environmental Protection Agency (CA-EPA) and the US Environmental Protection Agency (US-EPA) for air pollutant emissions, hazardous waste disposal, and toxic release inventory reporting (TRI). Specific CA-EPA agencies that Edwards AFB must deal with on a regular basis include California Air Resources Board (CARB) and Department of Toxic Substance Control (DTSC). In addition, Department of Defense (DoD), United States Air Force (USAF) and Air Force Materiel Command (AFMC) instructions and directives impose additional requirements for air pollutant emission source management, hazardous waste management and pollution prevention (P2).

Traditional environmental compliance includes paying fees, enacting procedures and processes to meet rules and regulations, and inspecting sites for compliance. In 1997, the Edwards AFB environmental compliance program addressed over 3,100 identified compliance sites (air emission sources, hazardous waste storage sites, installation restoration cleanup sites, under and above ground storage tanks, and water resources). The programmatic resources and costs required to address the resulting multiple compliance requirements are considerable. Even at a high level of programmatic integration, the current situation is at best a reactive approach to environmental management.

When practiced in a traditional manner, P2 includes source reduction and elimination, recycling and reuse, and treatment. Since 1994, the Edwards AFB P2 program was focused on achieving reductions in DoD, USAF and AFMC thrust areas (ozone depleting substances, US-EPA 17 chemicals, TRI chemicals and solid waste). While the short term resources and costs required for these P2 projects were often considerable, long term resource and cost reductions have been realized. However, within the DoD, USAF and AFMC guidances established for P2, compliance considerations were often not a motivating factor (although compliance was often recognized as a result). Although the methodologies for a P2 initiative driven by compliance considerations are essentially the same as the practices already in place, a formalized program is necessary to guarantee results.

A proactive P2 program seeks to reduce, and eventually eliminate compliance requirements and costs, while at the same time reducing pollution released to the environment. This concept can be best described as Compliance Through Pollution Prevention (CTP2). In DoD's current budgetary climate, CTP2 has the highest potential for achieving true long term environmental resource and cost reductions, an important consideration. The remainder of this paper demonstrates how a proactive CTP2 program driven by air quality compliance requirements at Edwards AFB has been developed.

2.0 CTP2 STRATEGY DEVELOPMENT

At Edwards AFB, the Environmental Management P2 Branch (EMCP) developed a strategy that addresses CTP2 within the context of the base's USAF mission and operations, and federal, state and local compliance requirements. Such a strategy, namely augmenting DoD, USAF and AFMC P2 objectives with ones that are derived from specific compliance requirements imposed on Edwards AFB, is a necessary first step to ensure that appropriate targets for CTP2 efforts are defined, and that subsequent P2 opportunity assessments are focused on those targets.

Edwards AFB is home to the Air Force Flight Test Center (AFFTC). The primary mission of AFFTC is the test and evaluation of USAF aircraft weapon systems. In the course of accomplishing its test missions, the center uses a wide

range of hazardous materials and processes, resulting in the generation of hazardous waste, air emissions and pollution. In 1997, over 2,700 identified air emission sources had some level of compliance requirements. These include:

- Permitted sources regulated by local air districts[1],
- Emission sources tracked for local reporting requirements[2],
- Emission sources tracked for California Air Toxics "Hot Spots" information and assessment[3], and
- National Emission Standard for Hazardous Air Pollutants (NESHAP) for aerospace manufacturing and rework (administered through the local air districts)[4].

The air quality compliance requirements for Edwards AFB are further complicated by the fact that the bulk of base is in a serious ozone non-attainment area (Kern County). It is important to recognize, however, that not only is such a circumstantial factor important in establishing rigorous compliance requirements, it is also a fundamental driver in setting CTP2 objectives that are appropriate for Edwards AFB.

To be effective, the CTP2 strategy for Edwards AFB must be proactive and anticipate and address future air compliance issues. Future air quality compliance requirements that will affect Edwards AFB include:

- US-EPA Clean Air Act (CAA) Title V permit (to be issued in late 1998)[5],
- CAA Risk Management Planning[6], and
- Future NESHAP requirements for jet engine and rocket motor testing.[7]

The basic CTP2 strategy for air quality compliance was developed to address three principle areas. These areas were selected based on having the greatest potential to reduce compliance resource and cost requirements in the present and future air quality compliance programs, and reduce environmental pollution. Activities designed to reduce compliance vulnerability were also identified.

2.1 Permit and NESHAP Compliance

In 1997, 446 emission sources were affected by permit and NESHAP compliance requirements. The strategy to reduce both current, and future, permit and NESHAP requirements includes; (1) eliminate requirement by reducing emissions, or other applicable factors, below compliance threshold; (2) reduce compliance operating conditions by reducing or eliminating specific pollutant emissions, or other applicable factors; and (3) reduce compliance administrative requirements by reducing emissions, or other applicable factors to well below their respective permitted limitations. Specific permitted and NESHAP compliance sources to be addressed by CTP2 are listed in table 1.

2.2 California Air Toxics Information and Assessment

In 1995, Edwards AFB provided an Air Toxics Information and Assessment update report to the local air districts for the reporting year 1994. At that time, and in conjunction with the program requirements, Edwards AFB was classified as an "Intermediate Level" facility due to having a prioritization score between 1 and 10.

In 1999, Edwards AFB will be required to submit an update report for reporting year 1998, followed by prioritization re-evaluation. If Edwards AFB can achieve a prioritization score of <1, then Edwards AFB would be reclassified as a "Low Level" facility and become exempt from further Air Toxics compliance and regulatory requirements. A secondary objective is to at least limit emissions of targeted Edwards AFB specific Air Toxics listed chemicals such that the 1998 prioritization score is maintained are at the current level. The methodology to achieve a prioritization score of <1, or the secondary objective, is to reduce emissions of targeted Edwards AFB specific Air Toxics listed chemicals to levels that will achieve the objectives. Specific Air Toxics chemicals to be addressed by CTP2 are listed in table 2.

2.3 Risk Management Planning

In 1999, Edwards AFB will be required to submit a risk management plan (RMP). Per the RMP requirement, Edwards AFB will fall into one of three possible "programs", each with differing levels of compliance requirements. Program 1 has the least requirements, while program 3 has the most extensive requirements. For Edwards AFB, the goal is to fall within the program 1 RMP requirement. The strategy to achieve the program 1 goal is to reduce the use or storage of targeted Edwards AFB specific RMP listed chemicals below their respective trigger thresholds. Specific RMP chemicals to be addressed by CTP2 are listed in table 3.

Table 1. Specific permitted and NESHAP compliance sources to be addressed by CTP2.

Source Category	Compliance Category	Process Description	Emissions
External Combustion	Local Air District Permits	Natural Gas Boilers	NOx
Internal Combustion	Local Air District Permits	Aircraft Ground Support Equipment (AGE)	NOx
Painting	Aerospace Rework NESHAP	Aircraft Paint Booths	HAPs
Jet Engine Test Cells	Jet Engine Testing NESHAP	Jet Engine Testing	NOx and HAPs

Table 2. Specific Air Toxics chemicals to be addressed by CTP2.

Chemical Name	Air Toxics Risk Category[1]	Primary Emission and Process Sources
Acrolein	Acute Non-Cancer	Jet Engine Testing
Chlorine	Acute Non-Cancer	Water Treatment
Chromium Compounds (Hexavalent)	Chronic Non-Cancer and Cancer	Aircraft Painting, Adhesive/Sealants, Soldering/Welding
Ethylene Glycol and Glycol Ethers	Acute Non-Cancer	Coolants
Isocyanate Compounds	Acute and Chronic Non-Cancer	Aircraft Painting, Adhesives/Sealants
Lead Compounds	Acute Non-Cancer	Jet Engine Testing, Soldering/Welding, Adhesives/Sealants
Nickel Compounds	Acute Non-Cancer	Soldering/Welding

[1] Air Toxics Risk Category refers to the 1994 risk prioritization results that had the greatest impact on the prioritization score.

Table 3. Specific RMP chemicals to be addressed by CTP2.

Chemical Name	Primary Process Sources
Chlorine	Water Treatment
Hydrogen Chloride	Rocket Motor Testing

3.0 CTP2 PROJECTS and PROGRESS

With a CTP2 strategy in hand and a list of targeted sources, the next step was to develop and apply specific CTP2 projects to address these sources.

3.1 PERMIT AND NESHAP COMPLIANCE

Sources addressed under the permit and NESHAP category represent sources that have the greatest potential for permit fee reduction or NESHAP compliance requirement reduction or elimination. A summary of the CTP2 projects and status for each source is given in table 4.

External Combustion: Natural gas fired boilers account for a significant fraction of permit fees and compliance costs (required periodic source testing). Boilers can be de-rated by adjusting the burners to reduce the boiler heat output to below permit threshold limits. The results are reduced emissions of nitrogen oxides (NOx), and elimination of permit compliance requirements (for boilers de-rated below 5 million BTU/hr) and source testing requirements (for boilers de-rated to between 5 and 10 million BTU/hr). Given the ozone non-attainment status of Kern County, sources of ozone precursors (such as NOx) can be expected to receive a high priority from local regulators. Thus efforts to reduce NOx emissions are aligned with regulatory agency priorities. In 1997, 23 boilers were identified[8] as potential candidates for de-rating, with an estimated $43,000/year cost savings. This project is currently under evaluation.

Internal Combustion: Internal combustion (IC) engines in aircraft ground support equipment (AGE) accounted for 38% of the total 1996 NOx emissions from Edwards AFB[9]. The major concern is the impact this source has on local ozone levels (NOx is an ozone precursor). Technologies for reducing NOx emissions from IC engines by 30-70% have been identified[10]. These IC engine technologies include water-in-fuel firing, selective catalytic reduction and NOx filtration. All of these technologies are currently under testing by the Air Force Research Laboratory (AFRL)

Table 4. CTP2 projects and status for permitted and NESHAP compliance sources.

Source Category	CTP2 Project	Project Status
External Combustion	De-rate boilers below 5 million BTU/hr, or between 5 and 10 million BTU/hr	Project under evaluation
Internal Combustion	Install IC Engine modifications (water-in-fuel firing, selective catalytic reduction) and NOx filters	On-going effort by Air Force Research Laboratory program - testing in progress
Painting	Weapon systems and base-wide P2 opportunity assessments to reduce hazardous material usage.	On-going effort for FY 1998
Jet Engine Test Cells	Research NOx (and potential HAP) control systems	FY00 SBIR Phase I

as part of a USAF wide technology needs study. Edwards AFB will continue to monitor these tests to identify those technologies that can be successfully implemented in the future.

Jet Engine Testing: Jet engine testing accounted for 47% of the total 1996 NOx emissions from Edwards AFB[9]. Jet engine testing also accounted for 21% of hazardous air pollutant (HAP) emissions in 1996. The major concern is the impact this source is having on local ozone levels. In addition, a NESHAP is expected for jet engine testing (due November 2000) and addressing possible source reduction options now could have long-term benefits for avoiding possible testing restrictions due to the new NESHAP. Technologies for reducing NOx emissions from jet engine testing have been identified[11,12], and may also have possible applications for HAP reduction (including Air Toxics chemicals). Edwards AFB plans to evaluate NOx and HAP control technologies for applicability to the base's test cells through a Small Business Innovation Research (SBIR) project.

3.2 California Air Toxics Information and Assessment

Sources addressed under the Air Toxics chemicals category represent sources that have the greatest potential to reduce the 1998 update prioritization evaluation score to <1. A summary of the CTP2 projects and status for each chemical is given in table 5.

Chromium Compounds (Hexavalent): Of the Air Toxics chemicals listed in tables 2 and 5, by far the most important to the CTP2 strategy for Air Toxics are hexavalent chromium compounds. Most of the sources that emit hexavalent chromium compounds are uncontrolled fugitive sources. Such sources lend themselves well to classic P2 opportunity assessments (PPOA). In a typical PPOA, chemical usage is evaluated and changes made to processes, procedures and materials to reduce or eliminate the chemical. Edwards AFB already has two PPOA projects that are on-going; a base-wide facilities opportunity assessment; and a weapon system specific opportunity assessment. Since most of hazardous materials used at Edwards AFB are for weapon system maintenance, a weapon system specific P2 opportunity assessment has the greatest potential for achieving the CTP2 goal for Air Toxics chemical reduction. Specific opportunity assessment recommendations are currently under development, with expected implementation to occur in FYs 1998 and 1999.

Ethylene Glycol and Glycol Ethers: One of the Air Toxics chemicals that is being addressed by a specific project is ethylene glycol and glycol ethers. The primary source of emissions for this chemical is from engine coolant losses during coolant change-outs. To minimize these losses, Edwards AFB is purchasing specialized recycling units that will recover the engine coolant, and filter the coolant for reuse. This project is in the equipment purchase phase and is expected to start up in mid 1998. An additional benefit of recycling ethylene glycol and glycol ethers is reduced generation of hazardous waste, and the resulting disposal costs and very significant compliance requirements. Indeed, this project is a prime example of how CTP2 can achieve impacts on different compliance program requirements.

All Other Air Toxics Chemicals: The same PPOA methodologies already discussed apply equally as well to the other Air Toxics chemicals. Specific PPOA recommendations are currently under development, with expected implementation to occur in 1998 and 1999. It is important to note that many of the CTP2 projects at Edwards AFB address multiple compliance issues. The PPOA projects discussed are the primary method for achieving NESHAP compliance for painting emission sources under permit compliance. The jet engine testing NOx reduction project also has the potential to reduce several Air Toxics chemicals.

Table 5. CTP2 projects and status for Air Toxics chemicals.

Chemical Name	CTP2 Project	Project Status
Acrolein	Research NOx (and potential HAP) control systems	FY00 SBIR Phase I
Chlorine	None	
Chromium Compounds (Hexavalent)	Weapon systems and base-wide P2 opportunity assessments to reduce hazardous material usage.	On-going effort for FY 1998
Ethylene Glycol and Glycol Ethers	Install coolant recycling systems for base-wide use	Equipment purchases in progress
Isocyanate Compounds	Weapon systems and base-wide P2 opportunity assessments to reduce hazardous material usage.	On-going effort for FY 1998
Lead Compounds	Weapon systems and base-wide P2 opportunity assessments to reduce hazardous material usage.	On-going effort for FY 1998
Nickel Compounds	Weapon systems and base-wide P2 opportunity assessments to reduce hazardous material usage.	On-going effort for FY 1998

3.3 RISK MANAGEMENT PLANNING

Sources addressed under the RMP chemicals category represent sources which have the greatest potential to achieve a level 1 RMP if their use or storage can be reduced to levels below RMP thresholds. A summary of the CTP2 projects and status for each chemical is given in table 6.

Chlorine: Based on 1997 use or storage, chlorine is the one RMP listed chemical that singularly puts Edwards AFB into at least a program 2 RMP. The biggest issue is storage in pressurized cylinders in excess of 2,500 pounds (the RMP trigger), and all in one location. Since the main application is for water treatment, a CTP2 project has been initiated to evaluate and implement better management practices to reduce storage below the RMP trigger.

Hydrochloric Acid: At Edwards AFB, hydrochloric acid occurs mainly as an unavoidable combustion product from rocket motor testing. It is of concern from a RMP perspective because rocket motor testing can generate and release large quantities very quickly (similar to an accidental release from a storage tank). Currently, possible options for controlling hydrochloric acid emissions from rocket motor testing are being investigated.

4.0 CONCLUSIONS

At Edwards AFB, a review of the base's air quality compliance requirements has led to the development of a CTP2 strategy that seeks to reduce and eliminate air quality compliance requirements and costs. This CTP2 strategy has led to several P2 projects (new and on-going) that are designed to achieve the CTP2 goals, and reduce pollution into the environment. Since most of these projects are in various phases (development, funding, on going and implementation) and not yet complete, the ultimate outcomes are still not known.

As promising as CTP2 appears to be, there are potential roadblocks. Most prominent of these roadblocks is the need to change "mind-set". Traditional environmental compliance amounts to little more than paying the "bill". This is often the most convenient way, and is the typical result of short term thinking. CTP2 requires that environmental professionals make a long-term evaluation of an environmental problem, and develop long term solutions to address it. Likewise, CTP2 will require negotiation with regulators to replace existing compliance conditions with a commitment to pursue P2, resulting in overall reductions in compliance requirements and fees. Almost as difficult as the "mind set" problem is the need for change in the way organizations plan funding. Often long term funding to reduce and eliminate environmental compliance is over ruled by the need to show short term return on investment, and demonstrate current compliance.

Irrespective of actual the actual monetary benefits realized, it is clear that CTP2 is a viable tool to achieving, maintaining and reducing compliance requirements. A successful CTP2 program requires formally developed

Table 6. CTP2 projects and status for RMP chemicals.

Chemical Name	CTP2 Project	Project Status
Chlorine	Implement better management practices for storage	Under discussion with base supply
Hydrogen Chloride	FY 2000 project under development	

strategies and objectives, and must be part of an overall P2 program. Faced with ever shrinking budgets, CTP2 has the highest potential for achieving true long term environmental resource and cost reductions, while at the same time achieving improvements to the quality of the environment. This is the essence of effective Environmental Leadership.

5.0 ACKNOWLEDGMENTS

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